

In the Specification:

On replacement page 1, line 1, replace the title with the following title:

COUPLING ELEMENT AND USE OF THE COUPLING ELEMENT IN A
DEVICE FOR MEASURING ANGLES

5 On replacement page 1 after the title and before line 3, insert the following new paragraphs and headings as follows:

A1 Applicant claims, under 35 U.S.C. §§ 120 and 365, the benefit of priority of the filing date of June 10, 2000 of a Patent Cooperation Treaty patent application, copy attached, Serial Number PCT/EP00/05372, filed on the aforementioned date, the
10 entire contents of which are incorporated herein by reference, wherein Patent Cooperation Treaty patent application Serial Number PCT/EP00/05372 was not published under PCT Article 21(2) in English.

Applicant claims, under 35 U.S.C. § 119, the benefit of priority of the filing date of July 1, 1999 of a German patent application, copy attached, Serial Number
15 299 11 508.9, filed on the aforementioned date, the entire contents of which are incorporated herein by reference.

Background of the Invention

Field of the Invention

20 Replace the paragraph beginning on replacement page 1, line 3 with the following paragraph:

A2 The present invention relates to a coupling element for connecting two components in a radially resilient, but torsion-proof manner.

On replacement page 1, between lines 4 and 5 insert the following heading:

A3

Description of the Related Art

Replace the paragraph beginning on replacement page 1, line 5 with the following paragraph:

A4

For manufacturing such coupling elements in a cost-effective manner, they

5 are made of one piece and shaped from sheet metal, such as described, for example, in DE 89 15 109 U1, EP 0 762 081 A1 and EP 0 762 082 A1. Note that EP 0 762 081 A1 corresponds to U.S. Patent No. 5,771,594 and EP 0 762 082 A1 corresponds to U.S. Patent No. 5,758,427, the entire contents of each of which are incorporated herein by reference. These coupling elements include a flat center piece as the base,

10 and of four brackets, formed thereon by bends. The brackets extend perpendicularly in relation to the level of the base, and respectively two brackets are arranged opposite and parallel to each other and form a spring parallelogram for radial compensation. To achieve the function of a spring parallelogram, the brackets extend axially and are formed at one location of the base and can be rigidly connected with one of the two

15 components at another location axially remote from the first. The torsion-proof property is reduced because of this axial remoteness and, in the course of a radial deflection of a spring parallelogram, the base is also unavoidably bent because of the axial linear change of the brackets. In an actual case, the base does not bend symmetrically here because of inhomogeneities in the base, because of which the base

20 introduces an angular twist in the remaining two brackets, which causes a mutual twisting of the two components connected via the coupling element.

[Replace the paragraph beginning at replacement page 1, line 20 with the following heading and paragraph:]

SUMMARY AND OBJECTS OF THE INVENTION

It is an object of the present invention to create a coupling element which is compactly and space-savingly constructed and can be produced cost-effectively.

Moreover, radial compensation movements of the two components connected by the coupling element should be possible without introducing impermissible mutual twisting between the two components.

[Replace the paragraph beginning at replacement page 1, line 25, with the following paragraph:]

This object is attained by a coupling element for an angle-measuring device for connecting a first component to a second component in a radially resilient, but torsion-proof manner with respect to an axis of rotation. The coupling element including a base and a first bracket rigidly fastened on the base and the first component, wherein the first bracket has a first outer support connection location, a second outer support connection location and an inner support connection location centered in a circumferential direction with respect to the axis of rotation between the first and second outer support connection locations. One of the first outer support connection locations of the first bracket and the inner support connection location of the first bracket forms a connection of the first bracket and the base and the other of the first outer support connection location of the first bracket and the inner support connection location of the first bracket is rigidly connected with the first component. A second bracket is rigidly fastened on the base and on the second component and which extends at a right angle with respect to the first bracket, wherein the second bracket has a first outer support connection location, a second outer support

connection location and an inner support connection location centered in a
 circumferential direction with respect to the axis of rotation between the first and
 second outer support connection locations of the second bracket. One of the first
 outer support connection locations of the second bracket and the inner support
 5 connection location of the second bracket forms a connection of the second bracket
 and the base and the other of the first outer support connection location of the second
 bracket and the inner support connection location of the second bracket is rigidly
 connected with the second component. Flexural strength of the first bracket in a
 region along the axis of rotation between the inner support connection location of the
 10 first bracket and a connecting line of the first and second outer support connection
 locations of the first bracket is considerably greater than the flexural strength in a
 region along a circumferential direction between the inner support connection location
 of the first bracket and the first and second outer support connection locations of the
 first bracket. Flexural strength of the second bracket in a region along the axis of
 15 rotation between the inner support connection location of the second bracket and a
 connecting line of the first and second outer support connection locations of the
 second bracket is considerably greater than the flexural strength in a region along a
 circumferential direction between the inner support connection location of the second
 bracket and the first and second outer support connection locations of the second
 20 bracket.

[Replace the paragraph beginning at replacement page 1, line 27 with the
 following paragraph:]

The present invention furthermore relates to the use of this coupling element

in an angle-measuring device.

A4
cmt

[Replace the paragraph beginning at replacement page 2, line 2, with the following paragraph:]

It is therefore a further object of the present invention to disclose an angle-measuring device, wherein the scanning unit is coupled to the stator of the angle-measuring device in a particularly torsion-proof, but radially resilient manner and, if possible, no measuring errors result from radial compensation movements between the scanning unit and the stator.

[Replace the paragraph beginning at replacement page 2, line 6, with the following paragraph:]

This object is attained by an angle-measuring device that includes a scanning unit, a stator and a coupling element connected to the stator and the scanning unit in a torsion-proof, but radially resilient manner with respect to an axis of rotation. The coupling element including a base and a first bracket rigidly fastened on the base and the first component, wherein the first bracket has a first outer support connection location, a second outer support connection location and an inner support connection location centered in a circumferential direction with respect to the axis of rotation between the first and second outer support connection locations. One of the first outer support connection locations of the first bracket and the inner support connection location of the first bracket forms a connection of the first bracket and the base and the other of the first outer support connection location of the first bracket and the inner support connection location of the first bracket is rigidly connected with the first component. A second bracket is rigidly fastened on the base and on the second

A4
ant

component and which extends at a right angle with respect to the first bracket,
wherein the second bracket has a first outer support connection location, a second
outer support connection location and an inner support connection location centered
in a circumferential direction with respect to the axis of rotation between the first and
5 second outer support connection locations of the second bracket. One of the first
outer support connection locations of the second bracket and the inner support
connection location of the second bracket forms a connection of the second bracket
and the base and the other of the first outer support connection location of the second
bracket and the inner support connection location of the second bracket is rigidly
10 connected with the second component. Flexural strength of the first bracket in a
region along the axis of rotation between the inner support connection location of the
first bracket and a connecting line of the first and second outer support connection
locations of the first bracket is considerably greater than the flexural strength in a
region along a circumferential direction between the inner support connection location
15 of the first bracket and the first and second outer support connection locations of the
first bracket. Flexural strength of the second bracket in a region along the axis of
rotation between the inner support connection location of the second bracket and a
connecting line of the first and second outer support connection locations of the
second bracket is considerably greater than the flexural strength in a region along a
20 circumferential direction between the inner support connection location of the second
bracket and the first and second outer support connection locations of the second
bracket.

(Replace the paragraph beginning at replacement page 2, line 8, with the

following paragraph:]

Particular advantages of the present invention are recited in the following description of exemplary embodiments.

5 [Replace the paragraph beginning at replacement page 2, line 11, with the following paragraph:]

Exemplary embodiments of the present invention are represented in the drawings.

[Replace the paragraph beginning on replacement page 2, line 13 with the following heading and paragraph:]

10 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a first exemplary embodiment of a coupling element, viewed in the axial direction according to the present invention;

[Replace the paragraph beginning at replacement page 2, line 15 with the following paragraph:]

15 FIG. 2 shows a lateral view of the coupling element in accordance with FIG. 1 taken along line II-II of FIG. 1;

[Replace the paragraph beginning at page 3, line 1 with the following paragraph:]

20 FIG. 3 shows a stereoscopic representation of the coupling element in accordance with FIGS. 1 and 2;

[Replace the paragraph beginning at page 3, line 3 with the following paragraph:]

FIG. 4 shows a top view of an embodiment of a shaft adapter with the

coupling element of FIGS. 1-3 in accordance with the present invention;

A4
cm
[Replace the paragraph beginning at page 3, line 5 with the following paragraph:]

FIG. 5 shows a partial sectional view of the shaft adapter of FIG. 4 taken
5 along lines V-V of FIG. 4 in accordance with FIG. 4;

[Replace the paragraph beginning at page 3, line 6 with the following paragraph:]

FIG. 6 shows an embodiment of an angle-measuring device with the coupling element in accordance with the present invention;

10 [Replace the paragraph beginning at page 3, line 8 with the following paragraph:]

FIG. 7 shows a second exemplary embodiment of a coupling element in accordance with the present invention; and

15 [Replace the paragraph beginning at page 3, line 9 with the following paragraph:]

FIG. 8 shows a stereoscopic representational view of a third exemplary embodiment of a coupling element in accordance with the present invention.

[Replace the paragraph beginning on page 3, line 11 with the following heading and paragraph:]

20 DESCRIPTION OF THE PREFERRED EMBODIMENT(S) OF THE INVENTION

A first exemplary embodiment of a coupling element 1 is represented in FIGS. 1 to 3. The coupling element 1 has been produced in one piece as a punched and bent element and is made of a material with a high degree of alternating stress resistance,

A4
CMT

in particular of spring steel. It includes a flat center area as the base 2, as well as four brackets 3, 4, 5, 6 formed thereon and bent at right angles. The brackets 3, 4, 5, 6 are aligned, at least to a large degree, parallel in relation to the axis D, they are furthermore arranged diametrically opposite each other and parallel with each other.

- 5 The bracket 3 is arranged diametrically opposite and parallel with the bracket 5. The bracket 4 is also arranged diametrically opposite and parallel with the bracket 6, wherein the brackets 3 and 5 extend at right angles to the brackets 4 and 6.

[Replace the paragraph beginning at page 3, line 20 with the following paragraph:]

- 10 Each bracket 3, 4, 5, 6 is fixed, centered atop a support on the base 2, and each bracket 3, 4, 5, 6 has respective further outer support connection locations or points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 on both sides of these inner support connection locations or points 3.1, 4.1, 5.1, 6.1. The diametrically oppositely located support points 3.2, 3.3 and 5.2, 5.3 are used for the rigid fastening of the brackets 3, 5 on one
- 15 of the two components, and the diametrically oppositely located support points 4.2, 4.3 and 6.2, 6.3 are used for the rigid fastening of the brackets 4, 6 on the other of the two components. All support points 3.1 to 6.3 advantageously lie in a common plane that extends at a right angle to an axis of rotation D of a shaft 31 of a rotor 30. The inner support points 3.1, 4.1, 5.1, 6.1 are centered in a circumferential direction with
- 20 respect to the axis C between corresponding outer support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3. The support points 3.1, 4.1, 5.1, 6.1 are formed by bending lines between the base 2 and the brackets 3, 4, 5, 6. The support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 are embodied as bores for fastening by screws, wherein the centers of

the bores are located together in the center plane of the base 2. However, other rigid fastening methods, for example welding, can also be provided. The three support points 3.1, 3.2, 3.3, 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 6.1, 6.2, 6.3 of each bracket 3, 4, 5, 6 are advantageously located on a common straight line, wherein the extensions of the straight lines enclose a rectangular square.

Replace the paragraph beginning at page 4, line 2 with the following paragraph:

The base 2 advantageously includes four braces, which connect the support points 3.1, 4.1 and 4.1, 5.1 and 5.1, 6.1, as well as 6.1, 3.1 in one plane and enclose a square. In this case the center lines of the braces extend at least approximately in the direction of the lines of application of the force which is introduced at the support points 3.1, 4.1, 5.1, 6.1.

Replace the paragraph beginning at page 4, line 6 with the following paragraph:

This described coupling element 1 can be employed in connection with angle-measuring devices in that it is inserted between the shaft of a drive mechanism and the shaft of an angle-measuring device. A shaft adapter 9 with the coupling element 1 in accordance with FIGS. 1 to 3 is represented in FIGS. 4 and 5. The coupling element 1 can be inserted in a particularly simple way between the shaft of the drive mechanism to be measured and the shaft of the angle-measuring device by this shaft adapter 9. The shaft adapter includes a first flange 9.1, on which the shaft of the drive mechanism can be rigidly fastened, and of a second flange 9.2, on which the shaft of the angle-measuring device can be rigidly fastened. In the example represented, the

first flange 9.1 is a plate with bores 9.11, so that the plate can be fixed in place on the shaft of the drive mechanism by being screwed together with it. The second flange 9.2 includes a second plate with a centered bore 9.21, in which the shaft of the angle-measuring device can be fixed in place by radial clamping.

AY
can
End

5 [Replace the paragraph beginning at page 4, line 18 with the following paragraph:]

The two outer support points 6.2, 6.3 and 4.2, 4.3 of the two diametrically oppositely located brackets 6 and 4 are rigidly connected with the first flange 9.1 by screws 8, and the two outer support points 3.2, 3.3 and 5.2, 5.3 of the brackets 3 and 5
10 extending at right angles to them are rigidly connected with the second flange 9.2 by screws 7. The two flanges 9.1, 9.2 are connected with each other via the coupling element 1 in a radially and axially resilient, but torsion-proof manner, in relation to the axis of rotation D. For reasons of clarity the support points of the brackets 3 to 5 have not been provided with reference symbols, reference is made with respect to this
15 to FIG. 3. The shafts of the drive mechanism and of the angle-measuring device have also not been represented for reasons of clarity.

Replace the paragraph beginning at page 4, line 31 with the following paragraph:

In a known manner, the angle-measuring device includes a stationary part,
20 also called mounting flange, of the angle-measuring device, or stator 10 in general, a scanning unit 20 and a rotating element, also called a rotor 30. The rotary position of the rotor 30 with respect to the stator 10 is measured. The rotor 30 in turn includes a shaft 31, which is seated in the scanning unit 20 and on which a code disk 32 is

AY
can

AS
cont

fastened. The scanning unit 20 includes a support body 21, on which a light source 22, a scanning plate 23 and a receiver unit 24 for the photoelectric scanning of the code disk 32 are arranged. The stator 10 can also be the stationary portion of a drive mechanism. For example the mounting flange of a motor, on which the scanning unit

5 is installed.

[Replace the paragraph beginning at page 5, line 8 with the following paragraph:]

The shaft 31 of this angle-measuring device can be rigidly installed on a shaft to be measured, because alignment errors are compensated by the coupling element 1,

10 which is integrated into the angle-measuring device. For this purpose, the brackets 4 and 6 are rigidly fixed in place on the stator 10 of the angle measuring device via the support points 4.2, 4.3, 6.2, 6.3. Only one of the screws 7 used for this is represented. The brackets 3 and 5 of the coupling element 1 are rigidly fixed in place on the scanning unit 20 by screws 8 via the support points 3.2, 3.3 and 5.2, 5.3. Because of

15 alignment errors between the shaft to be measured, not represented, and the shaft 32, the scanning unit 20 performs tumbling movements in relation to the stator 10, which are compensated by the coupling element 1 without the scanning unit 20 performing a rotation around the axis of rotation D in the process. If in the course of the rotation of the shaft 31 the scanning unit 20 is displaced in the radial direction R because of

20 alignment errors, the support points 3.2, 3.3 and 5.2, 5.3 of the brackets 3 and 5 are displaced in this direction R with respect to the support points 3.1 and 5.1. Because of the symmetrical arrangement of the support points 3.2, 3.3 with respect to the center support point 3.1, as well as the support points 5.2, 5.3 with respect to the

center support point 5.1, this displacement does not introduce a rotating movement into the coupling element 1. The actually occurring displacements are so small that they are compensated by the symmetrical stretching of the brackets 3 and 5 in the circumferential direction with respect to the axis of rotation D between inner support
 5 points 3.1, 4.1, 5.1, 6.1 and the outer support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3.

AB
End
 In connection with displacements of the scanning unit 20 in the radial direction perpendicular to R, the support point 6.1 is radially moved with respect to the support points 6.2 and 6.3, and the support point 4.1 is also radially moved with respect to the support points 4.2 and 4.3. The changes in distance occurring here between the
 10 support points 6.2, 6.1, 6.3 of the bracket 6, and between the support points 4.2, 4.1, 4.3 of the bracket 4, are again compensated by the symmetrical stretching in the brackets 6, 4.

Replace the paragraph beginning at page 6, line 14 with the following paragraph:

15 A second exemplary embodiment of a coupling element 1 is represented in FIG. 7. Since it essentially corresponds to the first exemplary embodiment, the same reference symbols are used and the description is limited to the differences. If
 AL
 particularly strong axial stiffness is demanded, the base 2 can be mechanically reinforced by the application of beads 2.1. If an axial fastening of the sheet metal
 20 brackets 3, 4, 5, 6, which are bent at right angles in relation to the base, is demanded, the ends with the support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 can be bent over into the plane of the base 2. All support points 3.1 to 6.3 (centers of the fastening points) again lie in a common plane.

[Replace the paragraph beginning at page 6, line 22 with the following paragraph:]

A6
m2

The further exemplary embodiment in accordance with FIG. 8 shows a coupling unit 100, wherein the brackets 103 to 106 are formed on the base 102 by their ends being bent at right angles, wherein the support points 103.2, 103.3, 104.2, 104.3, 105.2, 105.3, 106.2, 106.3, which are formed by the bending lines, are located in a common plane, in which the further support points 103.1, 104.1, 105.1, 106.1, which are symmetrically arranged between these support points 103.2 to 106.3, also lie. The center support points 103.1, 105.1 of the brackets 103, 105, which are located parallel across from each other, are used for fastening on one component (for example the first flange 9.1 in accordance with FIG. 4, or the stator 10 in accordance with FIG. 6), and the center support points 104.1, 106.1 of the further brackets 104, 106, which are located parallel across from each other, are used for fastening on the further two components (for example the second flange 9.2 in accordance with FIG. 4, or the scanning unit 20 in accordance with FIG. 6).

A7
cont

Replace the paragraph beginning at page 7, line 6 with the following paragraph:

The described coupling elements 1 and 100 have optimal dimensions, if all support points (3.1 to 6.3, 103.1 to 106.3) are located on a common straight line, and if furthermore all support points (3.1 to 6.3, 103.1 to 106.3) of all brackets (3, 4, 5, 6, 103, 104, 105, 106) are located in a common plane. For reasons of the available fastening opportunities it may be necessary to arrange the center support points slightly axially offset (parallel with the axis D) with respect to the further support

A7
END

points. The effect in accordance with the present invention of the coupling element is preserved, if the flexural strength of the brackets 3, 4, 5, 6 between the respective center support points 3.1, 4.1, 5.1, 6.1 and the connecting line with the further support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 (course of the brackets in the axial direction, also parallel with axis D), is considerably greater than the flexural strength between the center support points 3.1, 4.1, 5.1, 6.1 and the two further support points 3.2, 3.3, 4.2, 4.3, 5.2, 5.3, 6.2, 6.3 (course of the brackets in the circumferential direction, i.e. transversely to the axis D), so that in case of a radial displacement of the further support points with respect to the center support point, the brackets are respectively bent between the two further (outer) support points and are therefore stretched.

After line 20 at page 7 insert the following paragraph:

A8

The invention may be embodied in other forms than those specifically disclosed herein without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive, and the scope of the invention is commensurate with the appended claims rather than the foregoing description.

Replace the paragraph beginning at page 8, line 1, with the following paragraph:

— I Claim:

20 After page 10 add a new page 11 to read as follows:

— Abstract of the Disclosure

A9
cont

A coupling element for an angle-measuring device for connecting a first component to a second component in a radially resilient, but torsion-proof manner

AG
cut

with respect to an axis of rotation. The coupling element including a base and a first bracket rigidly fastened on the base and the first component, wherein the first bracket has a first outer support connection location, a second outer support connection location and an inner support connection location centered in a circumferential direction with respect to the axis of rotation between the first and second outer support connection locations. One of the first outer support connection locations of the first bracket and the inner support connection location of the first bracket forms a connection of the first bracket and the base and the other of the first outer support connection location of the first bracket and the inner support connection location of the first bracket is rigidly connected with the first component. A second bracket is rigidly fastened on the base and on the second component and which extends at a right angle with respect to the first bracket, wherein the second bracket has a first outer support connection location, a second outer support connection location and an inner support connection location centered in a circumferential direction with respect to the axis of rotation between the first and second outer support connection locations of the second bracket. One of the first outer support connection locations of the second bracket and the inner support connection location of the second bracket forms a connection of the second bracket and the base and the other of the first outer support connection location of the second bracket and the inner support connection location of the second bracket is rigidly connected with the second component. Flexural strength of the first bracket in a region along the axis of rotation between the inner support connection location of the first bracket and a connecting line of the first and second outer support connection locations of the first bracket is considerably greater than the